[CONTRIBUTION FROM THE LABORATORY OF AGRICULTURAL CHEMISTRY OF THE OHIO STATE UNIVERSITY.]

ON THE BEHAVIOR OF COAL-TAR COLORS TOWARD THE PROCESS OF DIGESTION.

BY H. A. WEBER.

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IT is very well known that the coal-tar colors have come into general use for coloring confectionery and other articles of food and drink. In fact they have almost completely superseded the vegetable colors, which have been used from time immemorial for a similar purpose. The indiscriminate use of these colors, some of which are derived from bodies of a decidedly poisonous nature, has often been regarded with suspicion by persons who are interested in public health. On account of the uncertainty existing in regard to these colors from a sanitary point of view, Austria has prohibited their use *in toto* in all articles of food and drink. Other countries prohibit certain of the colors, which have been shown to be injurious, and allow all others to be used.

The experiments made upon the lower animals have, in the main, revealed negative results. Thus the writer about eight years ago fed some of the colors most commonly employed by confectioners to rabbits in order to test this question. One-half gram of the colors, among which magenta and corallin were included, was fed to as many rabbits per day for ten days in succession without any apparent ill effects. The exhaustive treatise of Dr. Weil, translated by Leffmann, ascribes toxic effects to only a small number of the many colors employed by him in his experiments upon domestic animals.

The effect which these colors might exert upon digestive ferments, however, was a subject which had as yet received no attention, and the following experiments were undertaken in order to throw some light upon this question. The ferments employed were Armour's pepsin and pancreatine, liberal samples of which were kindly furnished by Armour & Co., of Chicago.

For the purpose of showing the digestive action, blood fibrin preserved in alcohol was employed. The fibrin was soaked and

thoroughly washed with water to remove the alcohol, then pressed between filter paper, and the amount required for each experiment weighed off.

In each set of experiments a control experiment was carried on without the addition of color. The mixture was made as follows :

Hydrochloric acid solution (two-tenths per cent.)	100 cc.
Pepsin	20 milligrams.
Fibrin	1 gram.

This mixture placed in a large test-tube was digested in a water-bath at a temperature of 38° to 40° C. until the fibrin was dissolved.

At the same time similar mixtures as above containing in addition 1, 0.5, 0.250, 0.125, and 0.062 gram of the color to be tested respectively, were digested in the same water-bath for the time required to dissolve the fibrin in the control experiment. Any fibrin remaining undissolved in the latter tests, was removed, thoroughly washed, pressed between filter paper as before and weighed.

1. PEPSIN AND OROLINE YELLOW.

This color was one of a series employed in the coloring of confectionery, and was found to be what is known in the trade as *Acid Yellow* or *Fast Yellow*, and is a mixture of sodium amidoazobenzenedisulphonate with sodium amidoazobenzenemonosulphonate.

	Amount of color. Gram	Amount of fibrin. Gram.	Amount of pepsin. Gram.	Duration of experiment. Hours.	Amouut of fibrin dissolved. Gram.
1	0.0	1	0.020	3	1.0
2	1.0	1	0.020	3	0.1
3	0.5	1	0.020	3	0.12
4	0.25	1	0.020	3	0.22
5	0.125	1	0.020	3	0.35
6	0.062	1	0.020	3	0.73

From this it will be seen that even in test No. 6, where the color employed amounted to only one part in 1600 parts of the solution, the presence of the color had still a depressing effect. For fear that, owing to the nature of this color, the hydrochloric acid might have been neutralized in part, the experiment was

repeated with a six-tenths per cent. solution of hydrochloric acid with similar results.

Of course the determination of the fibrin dissolved is only approximate, as can readily be inferred from the way it was done.

In tests Nos. 2, 3 and 4 no change in the amount of fibrin was apparent to the eye. That a small part of the fibrin had gone into solution was confirmed by the fact that a slight precipitate of albuminoids was obtained on the addition of a solution of tannin. On the whole it must be conceded that this color has a marked and injurious effect upon peptic digestion.

2. PEPSIN AND SAFFOLINE.

This is also a candy color and was found to be *acridine red.*

Amount of color. Gram.	Amount of fibrin. Gram.	Amount of pepsin. Gram.	Duration of experiment. Hours.	Amount of fibrin dissolved. Gram.
0.0	1	0.020	$3\frac{1}{2}$	1
1.0	1	0.020	5	1
0.5	1	0.020	5	1
0.25	1	0.020	5	1
0.125	1	0.020	$3\frac{1}{2}$	1
0.062	1	0.020	$3\frac{1}{2}$	1

As will be seen from the table above, this color only slightly retards the digestion of the fibrin in the three stronger solutions, while in the last two tests there was no interference with the process. On the whole it may be said that the effect of this color on peptic digestion is practically nil.

3. PEPSIN AND MAGENTA.

It is needless to tabulate the results of this experiment. Suffice it to say that the solution of the fibrin in the five tests containing the same proportions of the color as employed above kept pace throughout the whole duration of the experiment with the control test, the fibrin in all cases dissolving at the expiration of three and one-half hours.

This color, therefore, seems not to interfere with peptic digestion.

These four colors were also employed with pancreatin, and the method was as follows:

For the control experiment the following mixture was made:

Water	100 cc.
Sodium bicarbonate	1.5 grams.
Pancreatin	0.3 gram.
Fibrin	1.0 gram.

This mixture contained in a large test-tube, was digested in a water-bath until the fibrin was peptonized. To test the effect of the colors, there was added to similar mixtures as above 1, 0.5, 0.25, 0.125 and 0.062 gram of each color respectively.

5. PANCREATIN AND OROLINE YELLOW.

To the great surprise of the writer, this color, which had proved so effective in stopping and retarding peptic digestion, was found to exert no action whatever on the pancreatic ferment; the fibrin in all five of the tests with this color, dissolved as freely as that of the control test. The solution of the fibrin in all cases was completed at the expiration of six hours.

PANCREATIN AND SAFFOLINE.

The action of this color was quite different from that of oroline yellow, as the subjoined table will show:

	Amount of color. Gram.	Amount of fibrin. Gram.	Amount of Pancreatin. Gram.	Duration of experiment. Hours.	Amount of fibrin dissolved. Gram.
1	0.0	1	0.3	6½	1.0
2	1.0	1	0.3	6½	0.0
3	0.5	1	0.3	6½	0.0
4	0.25	1	0.3	6½	0.55
5	0.125	1	0.3	6½	0.65
6	0.062	1	0.3	6½	0.75

These results show, that in the two stronger solutions the action of the pancreatic ferment was entirely stopped, and that even in test No. 6, which contained only one part of color to 1600 of the solution the action of the ferment was retarded to a marked extent.

Tannin precipitates the coloring matter.

7. PANCREATINE AND MAGENTA.

This color was as marked in retarding and stopping the action of pancreatine as saffoline. The results are given in the table below:

	Amount of color. Gram.	Amount of fiber. Gram.	Amount of pancreatine. Gram.	Duration of experiment. Hour.	Amount of fiber dissolved. Gram.
1	0.0	1	0.3	6½	1.0
2	1.0	1	0.3	6½	0.0
3	0.5	1	0.3	6½	0.0
4	0.25	1	0.3	6½	0.40
5	0.125	1	0.3	6½	0.60
6	0.062	1	0.3	6½	0.73

The solutions of tests 2 and 3 gave no precipitate with tannin. In all other tests the precipitate was either marked or heavy.

8. PANCREATINE AND METHYL ORANGE.

This color in all of the tests behaved like the last three colors described, completely stopping the action of the pancreatine in the two strongest solutions and retarding it to a marked extent in the weakest. The tabular statement would be similar to the last.

It seems then, so far as these four colors are concerned, that none interfere with both peptic and pancreatic digestion, but that each color interferes seriously with either the one or the other. What the action of other coal tar colors may be, can, of course, not be inferred from this limited number of experiments, but it may safely be said that bodies which have such a decided action in retarding the most important functions of the animal economy, cannot properly have a place in our daily food and drink.

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THE ACTION OF ACID VAPORS ON METALLIC SULPHIDES.

BY JEROME KELLEY, JR. AND EDGAR F. SMITH.

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EXPERIMENTS made in this laboratory on the action of the vapors of hydrochloric acid upon the sulphide of arsenic proved that the latter is wholly volatilized. The purpose of the present communication is to record further observations along analogous lines. Thus, when washed and dried arsenic trisulphide is exposed to the action of hydrobromic acid gas, it volatilizes completely. Indeed the action commences in the cold with the formation of a liquid that passes out of the containing